

WATER QUALITY AND USE

Beneficial Use Attainment

Thirty-nine miles of the Salt River, 20 miles of Mark Twain Lake, 45 miles of the North Fork, and 49 miles of the Middle Fork are designated for public drinking water supply (MDNR 1986a). Only the lower Salt River from its mouth to Clarence Cannon Dam and Mark Twain Lake are classified for whole-body contact recreation. All streams listed by the Department of Natural Resources are designated for livestock and wildlife watering and protection of aquatic life. The primary deterrents to recreational use in the basin are high turbidity and siltation which are the results of poor soil management and bed scour (MNDNR 1986b). Excessive turbidity and siltation have not only decreased the abundance and diversity of aquatic life and habitat (Missouri Department of Conservation 1978), but have also made boating and canoeing more difficult due to locally heavy sedimentation. Fortunately, most streams in the basin have been spared from extensive channelization. Only the North Fork has been significantly channelized (42%). Channelization also affects recreational use by creating high banks and steep-sided channels making access difficult. The lack of public access in parts of the basin also limits recreational use.

Chemical Quality of Stream Flow

Water quality data was collected from basin streams at 12 sites around Mark Twain Lake prior to impoundment (U.S. Army Corps of Engineers, St. Louis 1974). For the most part, concentrations were within normal ranges during low or moderate stream flows. High measurements of turbidity, fecal coliform, iron, phosphorus, and nitrogen were usually associated with high flows. Although iron concentrations exceeded 20 mg/L at times, most was in the insoluble form which quickly settles out. Preimpoundment water quality information was also collected throughout the basin during 1969-70 by the Missouri Water Pollution Control Board (1970).

More recent water quality data is scarce. Data was recorded from the lower Salt River at the New London USGS gage station from 1967 to 1986. Selected parameters for the 1986 water year are presented in Table 6. Most measurements were within normal ranges during 1986 except during periods of high flow when fecal coliform and iron concentrations were high. The U.S. Army Corps of Engineers (St. Louis District) periodically collects water quality data at sites within Mark Twain Lake and just below the re-regulation dam on Salt River. The Clarence Cannon Water Treatment Plant monitors several parameters of raw water entering the plant from Mark Twain Lake. Like many reservoirs in agricultural watersheds, Mark Twain Lake has had atrazine levels above the maximum contamination level for drinking water (U.S. Army Corps of Engineers 1996). Rt. J Reservoir, a water supply reservoir owned by the city of Monroe City, has also had elevated atrazine levels. Although water treatment can remove this and other pesticides, the treatment process is expensive. Monroe City, with cooperation and assistance of several state, federal, and local agencies, and landowners, developed a comprehensive watershed management plan. In 1999, the "Route J Watershed Atrazine Abatement and Management Project" was implemented with the goal of reducing atrazine losses in field run-off while

maintaining effective weed control.

Other water quality research was conducted in the basin during the 1990's as part of the Agricultural Systems for Environmental Quality Project. This was a joint project of the USDA Agricultural Research Service (ARS), the University of Missouri, University Extension, and the USGS. Information on this project can be obtained by contacting the Cropping Systems and Water Quality Research Unit, USDA ARS, Room 269 Agr. Engineering Building, University of Missouri, Columbia, Missouri 65211. The purpose of the project was to determine the impact of prevailing cropping systems on ground and surface water quality (dissolved herbicides and nutrients). Findings of this work, much of which was conducted in the Salt River basin, can be found in Kitchen et al. (19xx), Donald et al. (1998), Blanchard and Donald (1997), Blanchard and Lerch (19xx), and Lerch and Blanchard (2003). Among the findings of these researchers was that many stream sites within the Salt River basin had elevated levels of herbicides, and percent losses of herbicides from claypan soil watersheds are high.

Suspended sediment discharge measured at the Middle Fork-Paris gage station during water year 1996 ranged from 0.26 to 26,500 tons/day. At the New London station (partial sediment data site), a suspended sediment discharge of 12,900 tons/day was recorded on May 7, 1996. Although highly variable from year to year, the average annual suspended sediment load in the Salt River at Monroe City from 1941 to 1965 was 1.215 million tons (Finney 1986).

Concerns listed by the Department of Natural Resources for the lower Salt River include chronic exceedences of secondary drinking water standards for manganese, occasional exceedences of whole fish standards for dieldrin and chlordane (MDNR 1986b). In the re-regulation pool below Mark Twain Lake, low dissolved concentrations caused by low flows of hypolimnetic waters from the lake through the turbines may significantly stress fish in the pool (see Dam and Hydropower Influences). Effluent from sewage treatment facilities or infrastructure in Kirksville, Macon, and Mexico have caused water quality problems in Bear Creek and Steer Creek, Sewer Creek, and South Fork, respectively. Facilities and operations in each of these cities have recently undergone improvements which should lessen impacts on receiving streams. Animal waste in streams can cause low levels of dissolved oxygen, high levels of ammonia, and can lead to nuisance algal blooms (MDNR unpublished). Although surface mining for coal in the Lick Creek and Littleby Creek watersheds has increased sulfate levels in the water, these increases are not of concern and are still below permitted maximums for drinking water supply and protection of aquatic life.

Fish Contaminant Levels and Health Advisories, Fish Kills

All of Missouri, including the Salt River basin, is under a Fish Consumption Advisory posted by the Missouri Department of Health. This advisory advises that women who are pregnant, who may become pregnant, nursing mothers, and children 12 years of age and younger not to eat any largemouth bass over 12 inches in length. This advisory was issued due to concerns about mercury contamination in largemouth bass and because of new risks estimates by the U.S. Environmental Protection Agency. North Missouri was once included in a limited consumption advisory for catfish, carp, drum, suckers, and paddlefish. However, this advisory was removed in 2001 because levels of contaminants, mainly chlorodane, have declined.

Low dissolved oxygen concentrations in the re-regulation pool between Clarence Cannon Dam and the re-regulation dam have been a major concern and a persistent problem. However, causes have been identified, water quality is now consistently monitored, and operational procedures at Clarence Cannon Dam are in place that will make oxygen problems in the pool less likely in the future. Other persistent water quality problems and fish kills have occurred in Bear Creek and Steer Creek due to sewage releases and overflows from Kirksville's wastewater treatment plant and infrastructure. Recent improvements at the plant have made future problems less likely.

Water Use

Mark Twain Lake is the largest water supply reservoir in the basin. The Clarence Cannon Wholesale Water Commission (CCWWC) currently distributes about 2.5 million gallons daily (mgd) to a large area around the lake and in some adjoining basins. The lake has the capacity to supply about 16 mgd. The CCWWC supplies water to Perry, Shelbyville, Paris, Madison, New London, Farber, Huntsville, Vandalia, Curryville, Lewistown, LaBelle, Edina, Shelby County PWSD (Public Water Supply District) #1, Knox County PWSD #1, Monroe County PWSD #2, Marion County PWSD #1, and Cannon PWSD #1, Thomas Hill PWSD #1, Pike County PWSD #1, and Lewis County PWSD #1. In addition to Mark Twain Lake, there are about 13 other municipal water supply reservoirs in the basin; however, some of these are not currently in use (Vandike 1995). The City of Shelbyville occasionally pumps water from the North Fork Salt River into their water supply reservoir. Total surface water withdrawals for North Fork, South Fork, and lower Salt River sub-basins are approximately 2.5, 5.5, and 3.0 million gallons per day, respectively. Industrial water withdrawals in the basin are relatively minor, totaling about 1.7 million gallons per day. Seventy-three percent of the 14,200 acres of irrigated land in the basin occurs in the South Fork sub-basin, mostly in Audrain County.

Point Source Pollution

Overall, point sources have a minor impact on streams in the basin. Waste water treatment facilities are the most common sources of point pollution (Table 7). Most have relatively small daily discharges. Only Shelbyville, Macon, Mexico, Moberly, and Kirksville discharge more than 0.5 million gallons daily into receiving streams. The Kirksville waste treatment facility has had problems in the past with the rotating biological contactor resulting in permit exceedences and discoloration and sedimentation of several miles of Bear Creek (MDNR unpublished). Recent improvements should lessen the likelihood of detrimental impacts in the future. Numerous small, privately owned point-source discharges (subdivisions, small businesses, schools etc.) occur in the basin. Stormwater run-off from several sand/gravel quarries, limestone settling ponds, clay pits and storage, and coal mining sites are also potential sources of pollution in the basin, especially in the South Fork sub-basin.

Concentrated Animal Feeding Operations

Audrain and Shelby counties are among Missouri's top swine producing counties. Most swine operations in the Salt River basin are relatively small compared to corporate farms that have recently ventured into the neighboring Chariton River basin. Corporate operations may develop

and have significant impacts in the Salt River basin in the future. Currently, the largest hog facility, located in the Spencer Creek watershed, handles about 8,500 head (Table 8). Another eleven farms retain more than 1,500 hogs. All of these privately-owned operations use anaerobic lagoons for treatment of excrement.

Non-point Pollution

Sedimentation and turbidity are the basin's most severe water quality problems (MDNR unpublished, Duchrow 1974). Intensive land cultivation has caused severe soil erosion throughout the watershed. Anderson (1980) reported 18 - 24 tons/acre/year of sheet and rill erosion from tilled land in the basin. Erosion from permanent pasture land averaged 2.5 - 5 tons/acre/year. Gully erosion was considered moderate at 100 - 199 tons/square mile annually. As a consequence, the watershed delivered about 2.9 tons/acre of sediment to basin streams annually and was ranked the tenth worst of 45 basins in the state. Streambank erosion contributes about 3% of the annual sediment load to basin streams. Sediment yield to Mark Twain Lake in 1988 was estimated at 1.85 million tons, 58% of which originated from cropland and 17% from floodplain scour (SCS 1988).

Agricultural run-off, which includes fertilizer, pesticides, herbicides, and animal waste, also poses a significant threat to water quality in the basin. During dry periods when stream flows are low, livestock and their waste concentrate around streams. These wastes can promote low levels of dissolved oxygen, high levels of ammonia, and excessive algal growth.

Table 6. Select water quality data for the Salt River near New London, Missouri in 1986 (USGS 1987).

| Parameter | State Standards | | | | 1986 Water Year |
|--|-------------------------------|---------|----|----------------------|-------------------------------------|
| | I | III | VI | VII | |
| Temperature (F) | 90 max | | | | 34-80 |
| Specific Conductance (micromhos/cm) | | | | | 132-270 |
| pH | | 6.5-9.0 | | | 6.8-8.8 |
| Coliform, fecal (cols/100ml) | | | | 200 non-storm runoff | 4 ^k -26,000 ^k |
| Hardness, total (mg/L as CaCO ₃) | | | | | 59-130 |
| Alkalinity, total (mg/L as CaCO ₃) | | | | | 44-105 |
| Nitrogen, Ammonia (mg/L as N) | depends on pH and temperature | | | | 0.02-0.11 |
| Phosphorus, total (mg/L as | | | | | 0.18-1.1 |

Table 6 continued

| | | | | | |
|--|-------|-----|--|-----|----------|
| P) | | | | | |
| Manganese, dissolved (microgram/L as Mn) | | 50 | | 50 | 29-43 |
| Iron, dissolved (microgram/L as Fe) | 1,000 | 300 | | 300 | 15-760 |
| Solids, residue susp. (mg/L as 356 degrees) | | | | | 96-184 |
| Oxygen, dissolved (mg/L) | 5 | | | | 6.4-14.4 |

I: protection of aquatic life

III: drinking water supply

VI: whole body contact recreation

VII: groundwater

^K: non-ideal colony counts**Table 7. Potential point-source pollution sites in the Salt River basin (MDNR unpublished). WWTF = Waste Water Treatment Facility.**

| Source | County | Receiving Stream | Location |
|---------------------|----------|----------------------|------------|
| Bowling Green WWTF | Pike | Peno Cr. | 27 53n 3w |
| Center WWTF | Ralls | Sugar Cr. | 30 55n 5w |
| Curryville WWTF | Pike | trib. to Spencer Cr. | 21 53n 4w |
| Frankford WWTF | Pike | trib. to Peno Cr. | 35 55n 4w |
| New London WWTF | Ralls | trib. to Salt R. | 6 55n 4w |
| Greentop WWTF | Schuyler | trib. to North Fork | 15 64n 15w |
| Brashear WWTF | Adair | Hog Br. | 29 62n 13w |
| Clarence WWTF | Shelby | Cat Br./North Fork | 9 57n 12w |
| Kirksville WWTF | Adair | Bear Cr. | 22 62n 15w |
| Queen City WWTF | Schuyler | North Fork | 26 65n 15w |
| Shelbina WWTF | Shelby | trib. to Clear Cr. | 29 56n 10w |
| Shelbyville WWTF | Shelby | trib. to Black Cr. | 36 58n 10w |
| Cairo WWTF | Randolph | trib. to Mud Cr. | 36 55n 14w |
| Jacksonville WWTF | Randolph | Hoover Cr. | 3 55n 14w |
| Clark WWTF | Randolph | Big Cr. | 23 52n 13w |
| Macon WWTF | Macon | Sewer Cr. | 14 57n 14w |
| Madison WWTF | Monroe | trib. to Elk Fork | 6 54n 13w |
| Moberly WWTF | Randolph | trib. to Coon Cr. | 6 53n 13w |
| Paris WWTF | Monroe | Middle Fork | 11 54n 10w |
| Renick WWTF | Randolph | Coon Cr. | 30 53n 15w |
| Sturgeon WWTF | Boone | Saling Cr. | 4 51n 12w |
| Moberly Corrections | Randolph | trib. to Coon Cr. | 25 53n 14w |

Table 7 continued

| | | | |
|-----------------------|---------|---------------|------------|
| Centralia WWTF | Boone | Goodwater Cr. | 9 51n 11w |
| Laddonia WWTF | Audrain | Youngs Cr. | 12 51n 11w |
| Perry WWTF | | Lick Cr. | 28 54n 7w |
| Mexico Works | | | 3 51n 9w |
| Mexico WWTF | Audrain | South Fork | 24 51n 9w |
| AP Green Indust. | Audrain | South Fork | 36 51n 9w |
| N. Amer. Refractories | Audrain | E. Lick Cr. | 21 52n 6w |

Table 8. Concentrated animal feeding operations in the Salt River basin with more than 1,500 units of livestock (source: Missouri Department of Natural Resources 1998).

| Type | Location | Units | Receiving Stream |
|-----------------|------------|-------|-------------------|
| swine finishing | 8 52n 10w | 1,920 | Goodwater Cr. |
| swine finishing | 8 52n 10w | 1,920 | Goodwater Cr. |
| swine finishing | 13 56n 13w | 3,840 | trib. Middle Fork |
| swine finishing | 33 55n 11w | 5,000 | Middle Fork |
| swine finishing | 8 55n 11w | 3,840 | Little Otter Cr. |
| swine finishing | 28 54n 12w | 1,920 | Elk Fork |
| swine finishing | 29 54n 12w | 1,920 | trib. Elk Fork |
| swine finishing | 35 56n 8w | 2,880 | trib. Indian Cr. |
| swine finishing | 17 54n 10w | 2,800 | trib. Elk Fork |
| swine finishing | 24 53n 6w | 8,520 | Spencer Cr. |
| swine nursery | 13 53n 13w | 6,400 | Galbreaths Cr. |
| swine finishing | 6 56n 11w | 2,000 | trib. Crooked Cr. |